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Staff Management of a Call Center using System Analysis and design

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The First Annual University of Windsor Undergraduate Research Conference

Staff Management at a Call Center

Engineering research and development project

Oral presentation Proposal

Submitted by

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Abstract

The call center operates 24x7 nowadays. With high demand of call centers being outsourced our team has developed an optimization model for companies to make profit with maximum customers being satisfied. As more customers are using the call centers, a number of issues have arisen. Some of the complaints received from customers are about the long waiting times to schedule an appointment or dealing with other customer issues. The managers are concerned about the inefficiency of operations at the call center. Our team has developed the program to solve all the issues that will be discussed in this report. In this report we focus on all the issues they might had and have tried to optimize the problems.

In this project, we are solving liner assignment problem where both full time and part time employers of the call center are being assigned to various time slots of a work day. A system analysis and application have been adopted to develop the decision support system to solve such a problem. System initiation has been performed where both IDEF and context model have been developed. System analysis followed by performing problem analytics, requirement analysis and logical design. Fishbone diagram process mapping and all mathematical problem have been developed tailored; the give model has been generalized to feed the general requirement of any assignment problem. Physical design is performed and flowcharts have been written for very small model of the system. For system construction and implementation, procedural programming have been used; however, VBA (Visual Basics for Applications) and RSP (Risk solver platform) object have been used for both properties and method. The application programming interfaces for the RSP solver have been called from within the Excel VBA script and forms, to automate the process of solving mathematical programming mode.

The excel file of the project will be presented during the presentation at the UWill Discover Undergraduate Research Conference.

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1. Introduction

Systems analysis is a problem-solving process which uses mathematical models and analytical techniques to investigate complex systems with a focus on an integrated, interdisciplinary approach. It is the second stage in the system development life cycle (SDLC), which is a conceptual model used in project management that describes the stages involved in an information system development project, from an initial feasibility study through maintenance of the completed application. Figure 1 on the next page will illustrate the process of it in sequence.

The person who analyzes the systems is the Systems Analyst, who studies the problems and needs of an organization to determine how people, data, processes and information technology can best accomplish improvements for the business. Systems analysis is important because it seeks to understand what humans need to analyze data input or data flow systematically, process or transform data, store data, and output information in the context of a particular business. Furthermore, systems analysis and design is used to analyze, design, and implement improvements in the support of users and the functioning of businesses that can be accomplished through the use of computerized information systems. Installing a system without proper planning leads to great user dissatisfaction and frequently causes the system to fall into disuse. Systems analysis and design lends structure to the analysis and design of information systems, a costly endeavor that might otherwise have been done in a haphazard way. It can be thought of as a series of processes systematically undertaken to improve a business through the use of computerized information systems. Systems analysis and design involves working with current and eventual users of information systems to support them in working with technologies in an organizational setting. It can be used in various fields from industrial applications for process optimization, budgetary decisions for cost optimization and even to military applications. According to Leen Hordjik (*Options Magazine*, winter 2007), “it is possible to explain systems analysis using a framework that’s made up of nine steps”;

1. Gather all information and knowledge related to the problem
2. Determine the objective of the stakeholders
3. Determine ways of achieving the objectives and design new alternatives if necessary.
4. Consider the problem in the light of the knowledge accumulated
5. Estimate the impacts of the various possible courses of action, taking
into account the uncertain future and the organizational structures that are required to
implement our proposals.
6. We assess the compared alternatives to see possible impacts and consequences.

7. Present the results in framework that facilitates choice by the stakeholders.
8. Provide follow-up assistance
9. Evaluate the results.

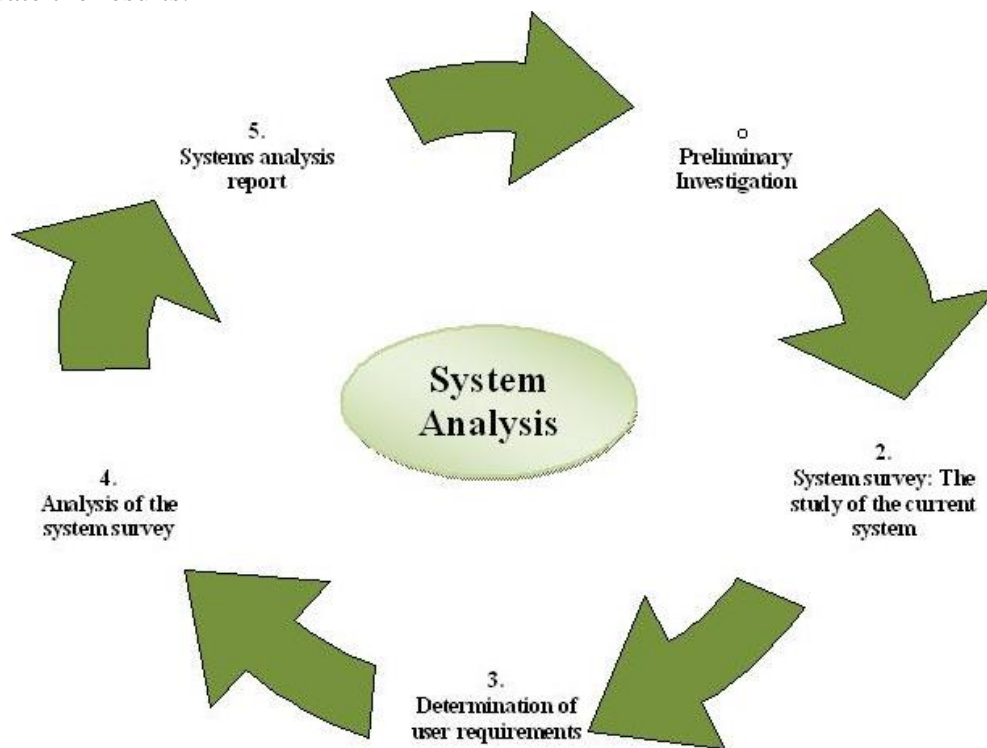


Figure 1: Illustration of the five stages of Systems Analysis (searchsoftwarequality, 2015)

The project was kick started by first setting up the System Development Process, which is a set of methods and automated tools that stakeholders use to develop and maintain information systems and software, by breaking down the process into four stages. The first is the **system initiation & scope definition**, where the problem is identified, and this is done with the help of IDEF (Integrated Definition Modelling Techniques and Context Diagram. Second is the **system analysis** stage, where the problem is analyzed and the requirements and expectations of the solution is identified, this was done using Fishbone Diagram (Ishikawa Diagram). Third is the **system design** stage where the best solution is chosen and designed, this was done using Data Flow Diagrams and flowcharts for the procedures and sub-procedure. The fourth and final stage is the system implementation stage, where the chosen solution is implemented and the results are evaluated, this is done by using Microsoft Excel and Visual Basic Applications, in which RSP VBA codes were used to solve the problem. Project Management was done using Gantt chart that is also included in the report. The results found of the project are also incorporated in the report and Excel file.

2. Literature Review

Coding is a concentrated movement begins when configuration group is last with the physical outline determination to transform the framework into working machine code. Despite the fact that testing is parallel to coding however it likewise needs fitting wanting to attain to the planned goals of the framework. Establishment of a framework is the replacement of a current framework with the new one and incorporates change of existing information, programming, documentation and work methodology as indicated by new framework. The results of these exercises are code, ace gram documentation, test arrangement, test information, test outcomes, client guides, client preparing arrangement, establishment and change arrangement, equipment and programming establishment plan, information transformation plan and site and office redesigning arrangement. The procedure of documentation is brought throughout the life cycle of the framework however on this stage all the data about the framework are appropriately and completely archived both for clients and maintainers of the framework. In enterprises there may be specific staff to give preparing to support laborers and clients and in little association a few clients can be prepared and rest can gain from them. The results of these initiates are framework documentation, client documentation, client instructional courses, client training classes, etc. The methodology of keeping up a data framework is really coming back to the start of SDLC and repeating improvement steps. Four noteworthy exercises happen within maintenance, acquiring support appeals, planning changes and actualizing changes. The result of support action is new form of framework alongside overhaul in all sort of documentation. In a system development life cycle, this is the last stage and prompts the start of a framework improvement so this is an essential issue to manage serious consideration.

3. Methodology

The methodology concepts used in the project are as follows;

3.1 Problem Analysis

3.1.1 Integer Programming Model

Programming model used for this sample project are as follows:

Hour	Expected No. Of Calls
7 A.M. - 9 A.M.	55 calls
9 A.M. - 11 A.M.	90 calls
11 A.M. - 1 P.M.	80 calls
1 P.M. - 3 P.M.	93 calls
3 P.M. - 5 P.M.	85 calls
5 P.M. - 7 P.M.	45 calls
7 P.M. - 9 P.M.	20 calls

Table 1: Expected number of calls

3.1.2 Decision Variables

- x₁ The total number of full-time employees who work from 7A.M. to 3P.M. Their salary is \$112 per day.
- x₂ The total number of full-time employees who work from 9A.M. to 5P.M. Their salary is \$112 per day.
- x₃ The total number of full-time employees who work from 11A.M. to 7P.M. Their salary is \$116 per day.
- x₄ The total number of full-time employees who work from 1P.M. to 9P.M. Their salary is \$120 per day.
- x₅ The total number of part-time employees who work from 1P.M. to 5P.M. Their salary is \$40 per day.
- x₆ The total number of part-time employees who work from 3P.M. to 7P.M. Their salary is \$44 per day.
- x₇ The total number of part-time employees who work from 5P.M. to 9P.M. Their salary is \$48 per day.

3.1.3 Objective Function

The objective is to minimize the total cost of operating

$$\text{Min: } 112x_1 + 112x_2 + 116x_3 + 120x_4 + 40x_5 + 44x_6 + 48x_7$$

3.1.4 Constraints

$$x_1 \geq 55/6$$

$$x_1 + x_2 \geq 90/6$$

$$x_1 + x_2 + x_3 \geq 80/6$$

$$x_1 + x_2 + x_3 + x_4 + x_5 \geq 93/6$$

$$x_2 + x_3 + x_4 + x_5 + x_6 \geq 85/6$$

$$x_3 + x_4 + x_6 + x_7 \geq 45/6$$

$$x_4 + x_7 \geq 20/6$$

$$x_1, \dots, x_7 \geq 0$$

$$x_1, \dots, x_7 \text{ int}$$

3.2 System initiation

3.2.1 IDEF - Integrated Definition Modeling Techniques

Definition: IDEF is the common name referring to classes of enterprise modeling languages.

Objective: IDEF is used for modeling activities necessary to support system analysis, design, improvement or integration. (Ozgun Demirag, 2004)

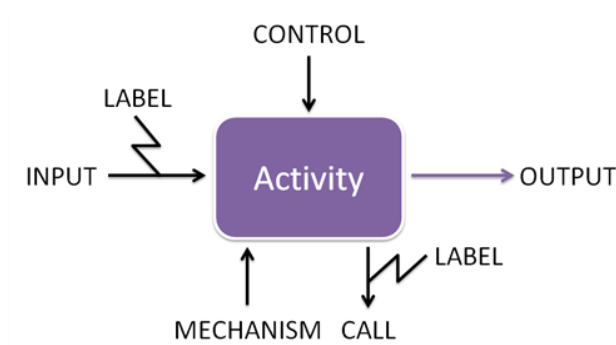


Figure 2: Sample IDEF diagram (*Ergonomics & Human Factors, n.d.*))

The IDEF for this project is as follows:

Inputs for our project are Number of calls and Working Hours. The controls are total number of employees, number of calls answered and salary. The mechanisms used were linear programming, Excel VBA and Risk solver. Therefore the outputs we get is the optimal number of Full-time, Part-time employees and operating cost of call center.

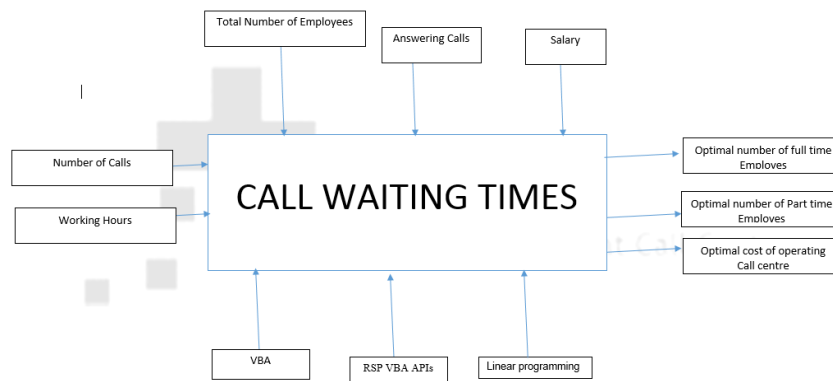


Figure 3: IDEF for Call Waiting Times

3.3 System Analysis

3.3.1 Context level Diagram

A Context Diagram is a single picture that has the system of interest at the center, with no details of its interior structure or function, surrounded by those elements in its environment with which it interacts.

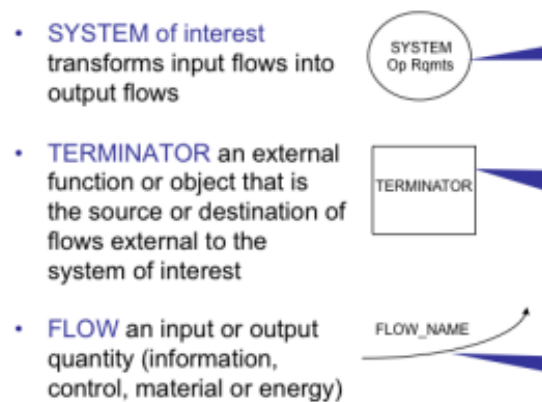


Figure 4: Legend about Context Level Diagram (Burge, 2011)

As seen in figure 5 the systems of interest we have are shift and employee allotment of the call center, management, patients and employees are inputs whereas time allocation and shift allocation are outputs.

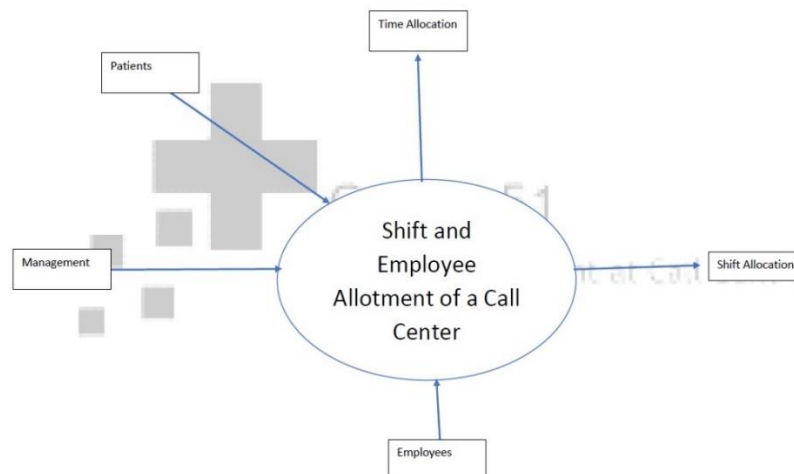


Figure 5: Context Level diagram for shift and employee allotment of a call center

3.3.2 Fishbone Diagram

Cause and Effect Analysis which is used to identify the issues we encounter.

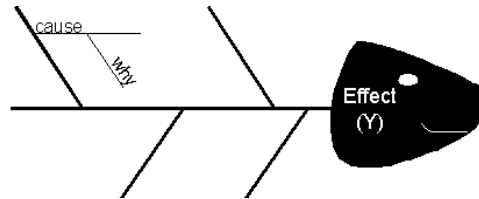


Figure 6: sample fishbone diagram (Simon, n.d.)

Slow response time is our effect of the call center as seen in figure 7. This effect is caused by four factors which include employees, management, process involved and patients calling the call center.

Employees factor is important here because it involves how many calls they get, are they full time or part time, the pay they get and experience they have to provide service to customers.

Management effect slow response time because they have been doing bad scheduling of employees, lack of strategies they have and main focus they are having is how can they be cost efficient.

The process and patients effect this as patients don't know which department's they want to contact and the call transferring is also slow between departments.

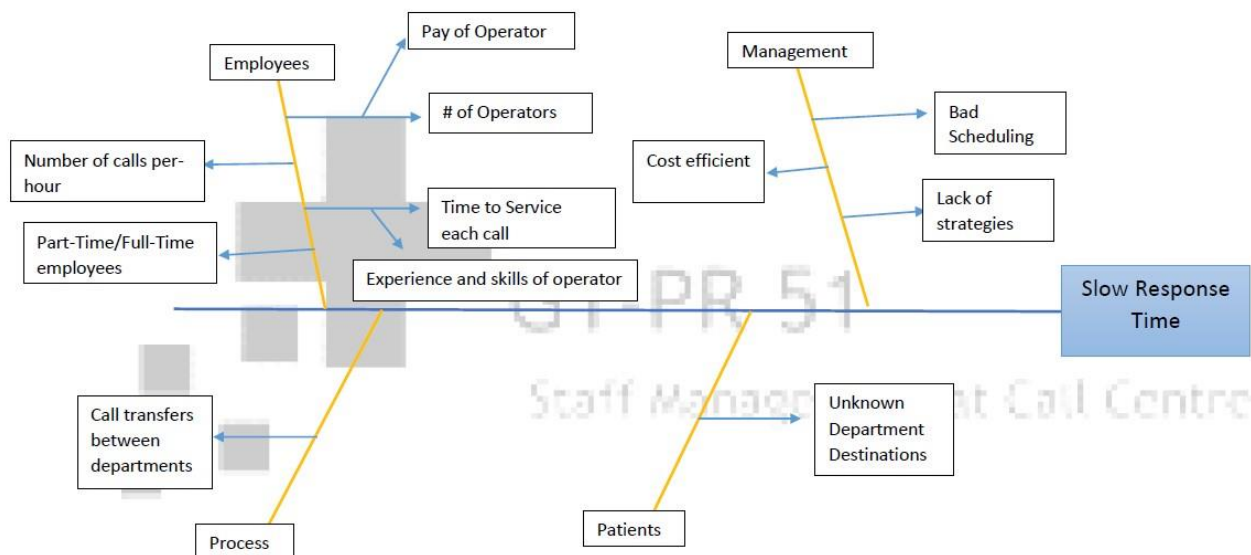


Figure 7: Slow Response Time fishbone diagram

3.4 Physical Design

3.4.1 Process Mapping Chart

Flowcharts are easy-to-understand diagrams showing how steps in a process fit together. This makes them useful tools for communicating how processes work, and for clearly documenting how a particular job is done.

The Flowchart figure 8 below shows the procedure on how customer calls are processed. Customers are given three different options when the phone is first answered, press 1 if they want to make a doctor's appointment, 2 if they want to schedule lab work and 3 if he or she is a new patient. If there's no response from the customer, the menu would play back. The playback procedure would repeat for three times, and if there's still no response after the third time, it automatically ends the call. Now for the sub-procedures, if option 1 is selected, the customer will be notified that the call will be monitored for quality and training purposes while the call is being transferred to the next available agent. If there's an available agent; the call will be answered, if no not, the call will go back to waiting line for another agent. This sub-procedure will be used for the other two options as well also seen in figure 9, 10 and 11.

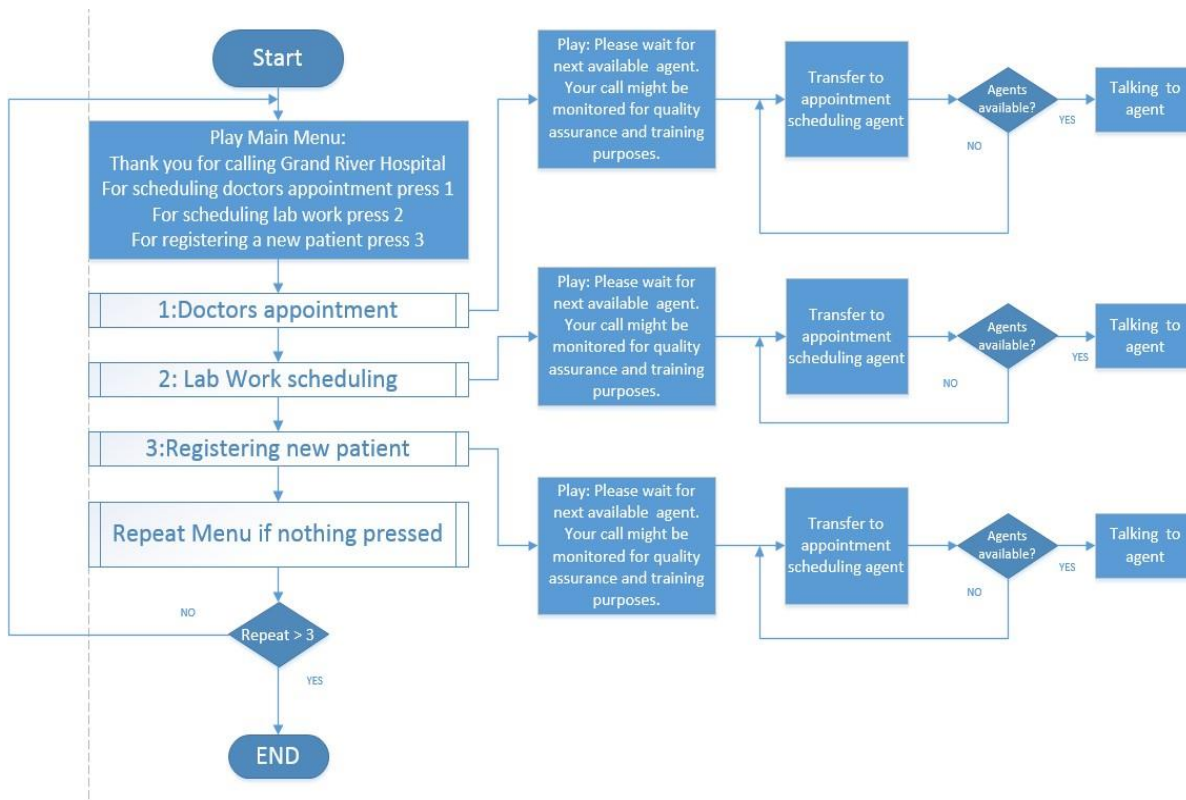


Figure 8: Process Map of Call Centre.

3.4.2 Doctors Appointment Flowchart

For doctor's appointment customer selects option 1, and the following procedure is followed.

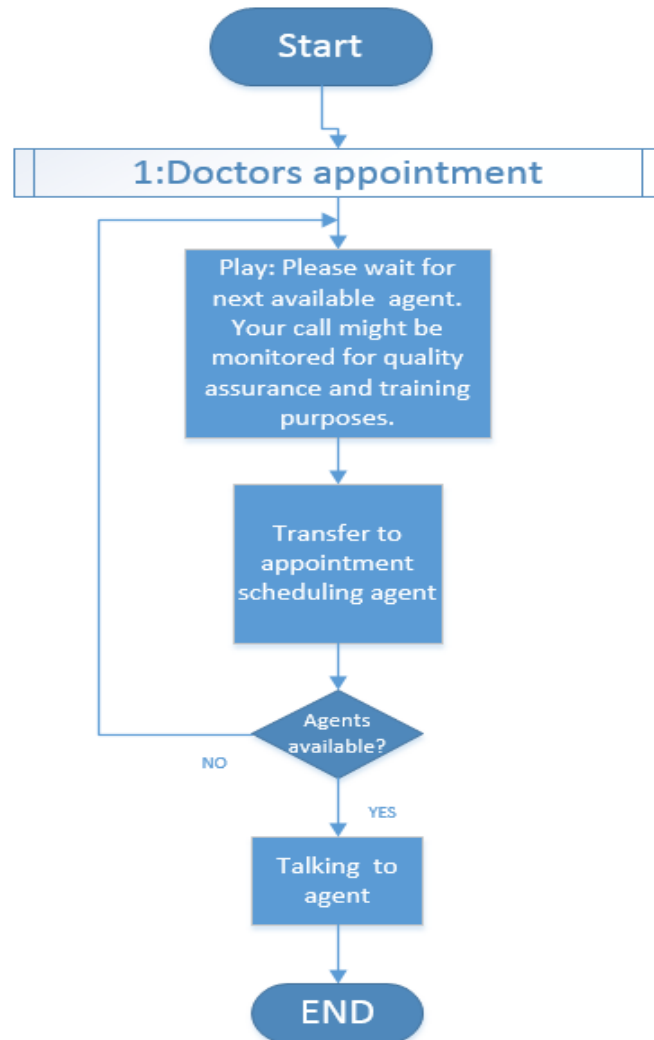


Figure 9: Doctors Appointment Flowchart

3.4.3 Lab Work Scheduling Flowchart

For Lab Work Scheduling customer selects option 2, and the following procedure is followed.

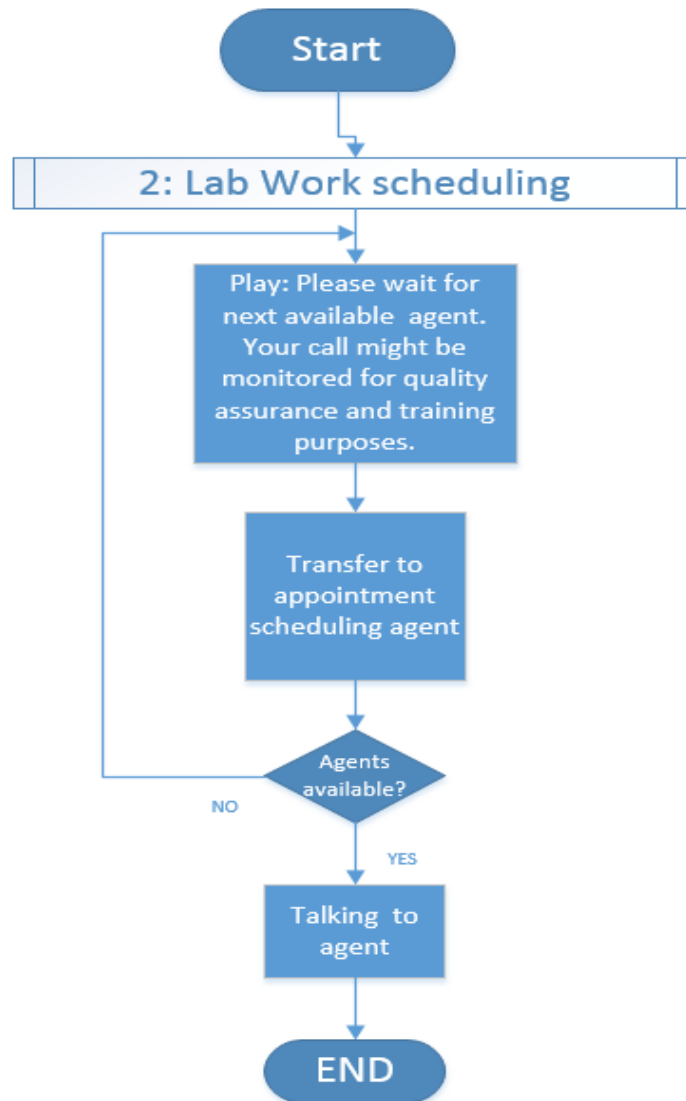


Figure 10: Lab Work Scheduling Flowchart

3.4.4 Registering New Patient Flowchart

For Registering New Patient customer selects option 3, and the following procedure is followed.

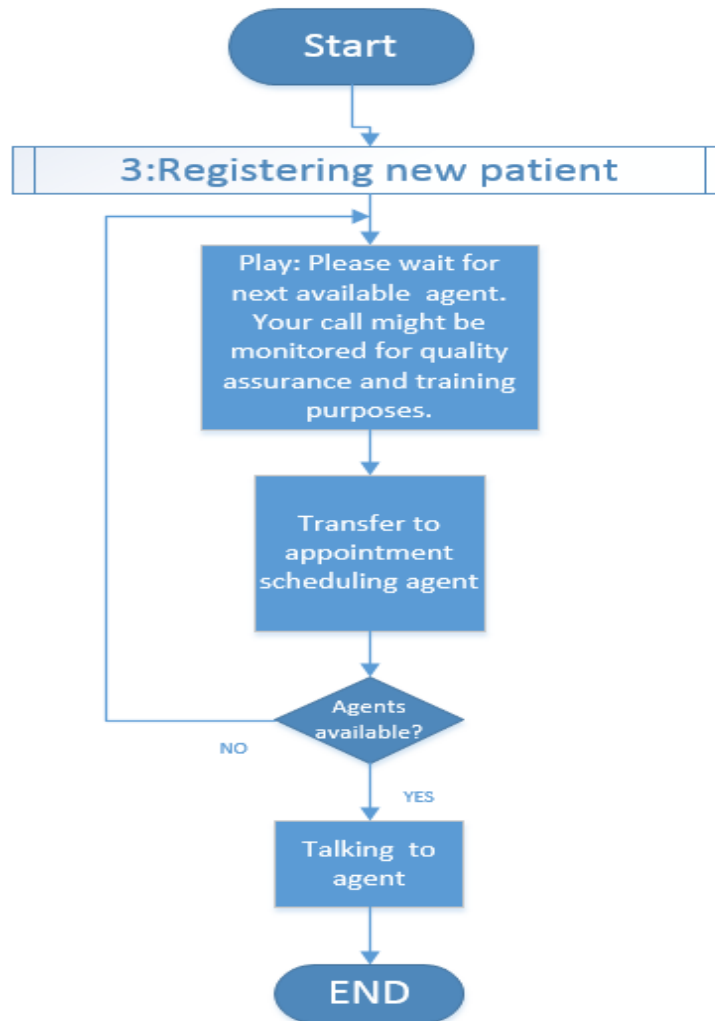


Figure 11: Registering New Patient Flowchart

3.4.4 Flowchart for Data Sheet Button

The Date Sheet button used on the excel sheet follows the following procedure to operate when clicked on the data sheet button seen on the excel worksheet.

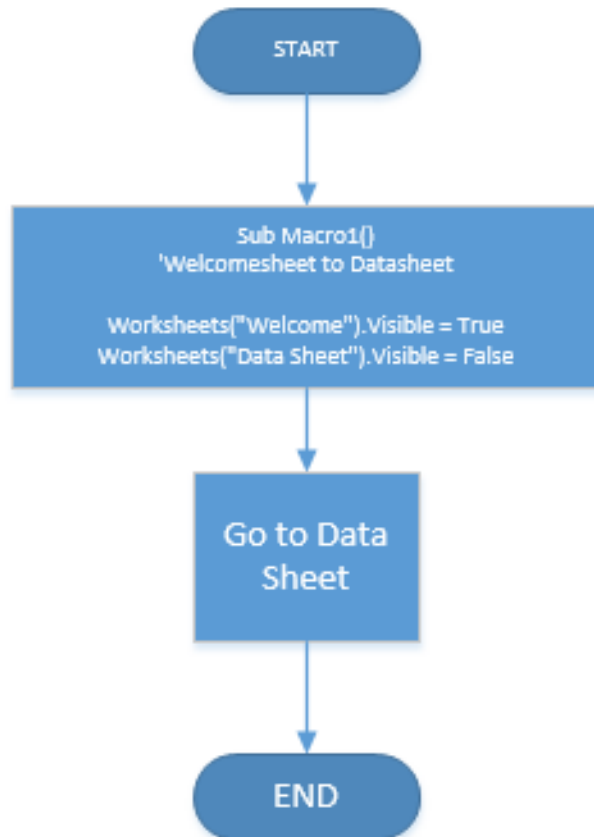


Figure 12: Flowchart for Data Sheet Button

3.4.5 Flowchart for Welcome Sheet Button

The welcome button used on the excel sheet follows the following procedure to operate when clicked on the welcome sheet button seen on the excel worksheet.

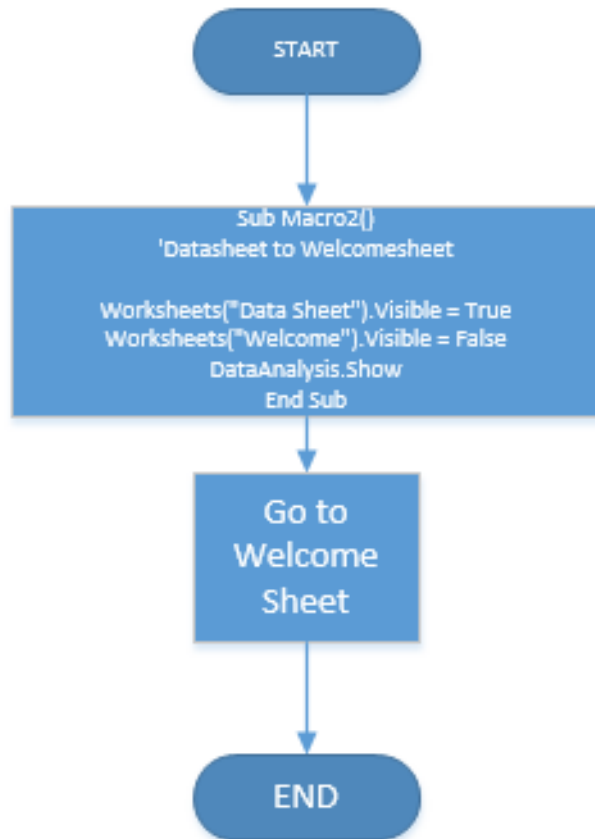


Figure 13: Flowchart for Welcome Sheet Button

3.4.6 Sensitivity Analysis

Sensitivity Analysis is extremely valuable when endeavoring to focus the effect the real result of a specific variable will have in the event that it contrasts from what was already expected. By making a given set of situations, the analyst can decide how changes in one variable(s) will affect the target variable. There are certain questions that are addressed by sensitivity analysis, such as how much will the results change if my data is not accurate? Will this have a minor or major impact on the results? The most important question is whether my optimum solution is sensitive to any kind of changes in the original problem coefficients? If the objection function, Z or a decision variable such as X_i change when an original coefficient is changed, then we say that the LP model is sensitive.

In the case of our project, the parameters that are being examined here are the number of employees, which is a decision variable, and how this variable will affect the output if any original coefficient is changed.

3.5 System Implementation

3.5.1 Welcome page

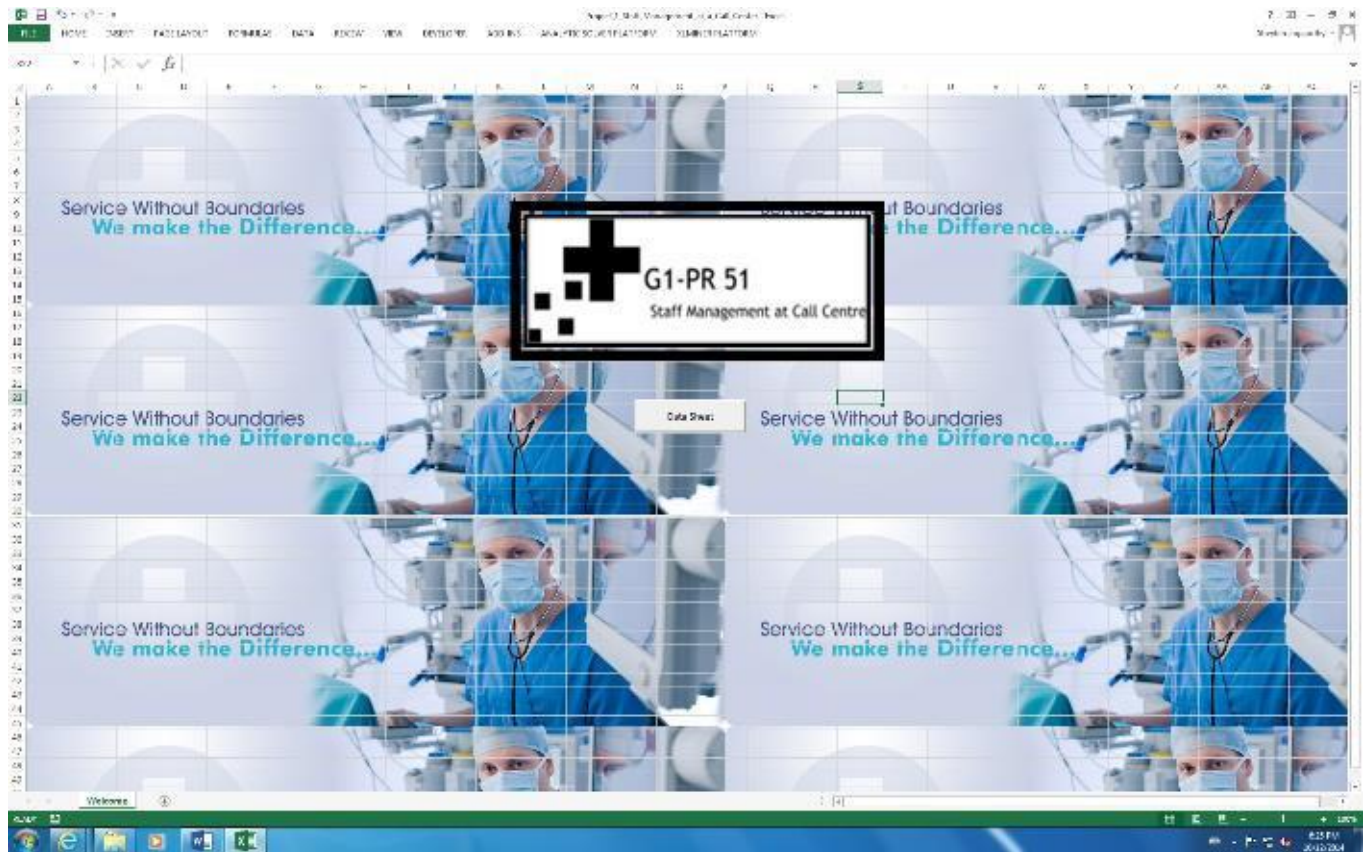


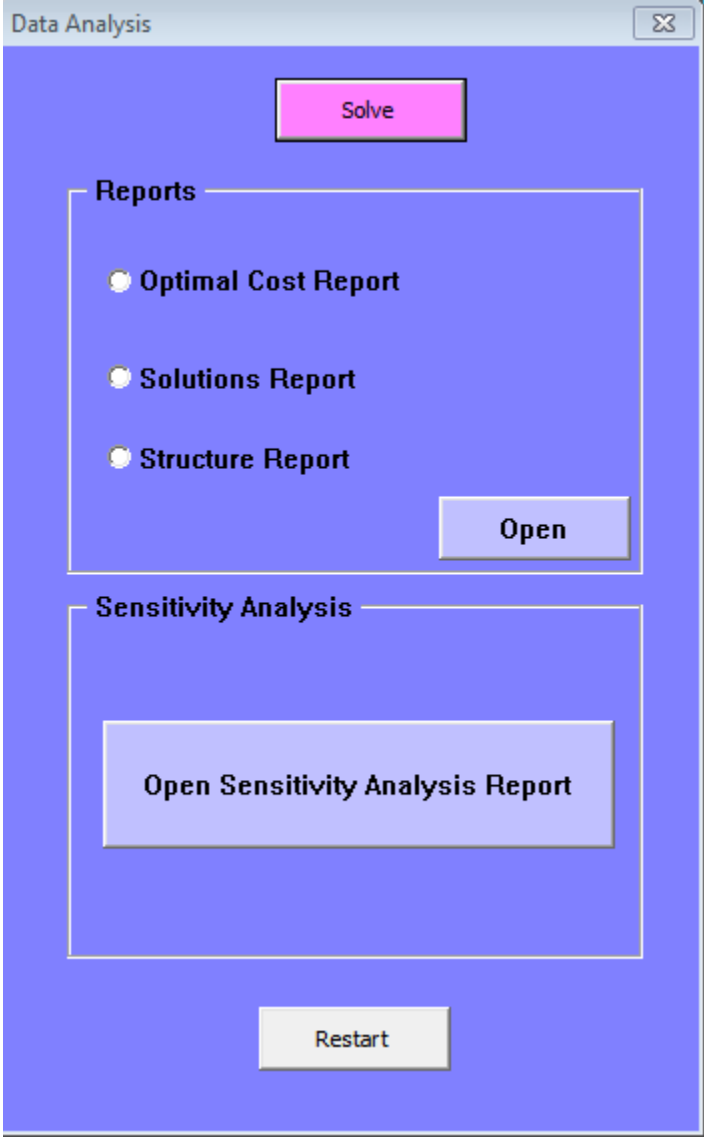
Figure 14: Welcome page preview

3.5.2 Sample Data Sheet

	A	B	C	D	E	F	G	H
1	Hour	Expected No. of Calls						
2	7A.M. - 9A.M.	55.00						
3	9A.M. - 11A.M.	90.00						
4	11A.M. - 1P.M.	80.00						
5	1P.M. - 3P.M.	93.00						
6	3P.M. - 5P.M.	85.00						
7	5P.M. - 7P.M.	45.00						
8	7P.M. - 9P.M.	20.00						
9								
10	Decision Variables					Constraints		
11	X1				0.00	>=	9.17	
12	X2				0.00	>=	15.00	
13	X3				0.00	>=	13.33	
14	X4				0.00	>=	15.50	
15	X5				0.00	>=	14.17	
16	X6				0.00	>=	7.50	
17	X7				0.00	>=	3.33	
18								
19		Salary			Obejective func		0	
20	X1	112.00						
21	X2	112.00						
22	X3	116.00						
23	X4	120.00						
24	X5	40.00						
25	X6	48.00						
26	X7	48.00						

Figure 15: Sample Data Sheet preview

3.5.3 User Form



The image shows a software window titled "Data Analysis" with a close button in the top right corner. The window has a blue background and contains several interactive elements:

- A pink "Solve" button at the top center.
- A "Reports" section containing three radio buttons:
 - ☐ Optimal Cost Report
 - ☐ Solutions Report
 - ☐ Structure Report
- An "Open" button located to the right of the radio buttons.
- A "Sensitivity Analysis" section containing a large button labeled "Open Sensitivity Analysis Report".
- A "Restart" button at the bottom center.

Figure 16: User Form preview

Salaries of employess

Shift Salary

Full Time Employee Part Time Employee

1 P.M- 5 P.M	<input type="text"/>
3 P.M - 7 P.M	<input type="text"/>
5 P.M - 9 P.M	<input type="text"/>

Average Number of Calls per Hour

Enter Data Cancel

Solver

Number of Calls

HOUR	Expected No. Of Calls
7 A.M - 9 A.M	<input type="text"/>
9 A.M - 11 A.M	<input type="text"/>
11 A.M - 1 P. M	<input type="text"/>
1 P.M - 3 P.M	<input type="text"/>
3 P.M - 5 P.M	<input type="text"/>
5 P.M - 7 P.M	<input type="text"/>
7 P.M - 9 P.M	<input type="text"/>

Figure 17 User Form to input data

3.5.4 Project Management & Scheduling

This project was started and completed in Fall 2014. The process of scoping, planning, staffing, organizing, directing, and controlling the development of an system at a minimum cost within a specified time frame was done using Gantt Chart.

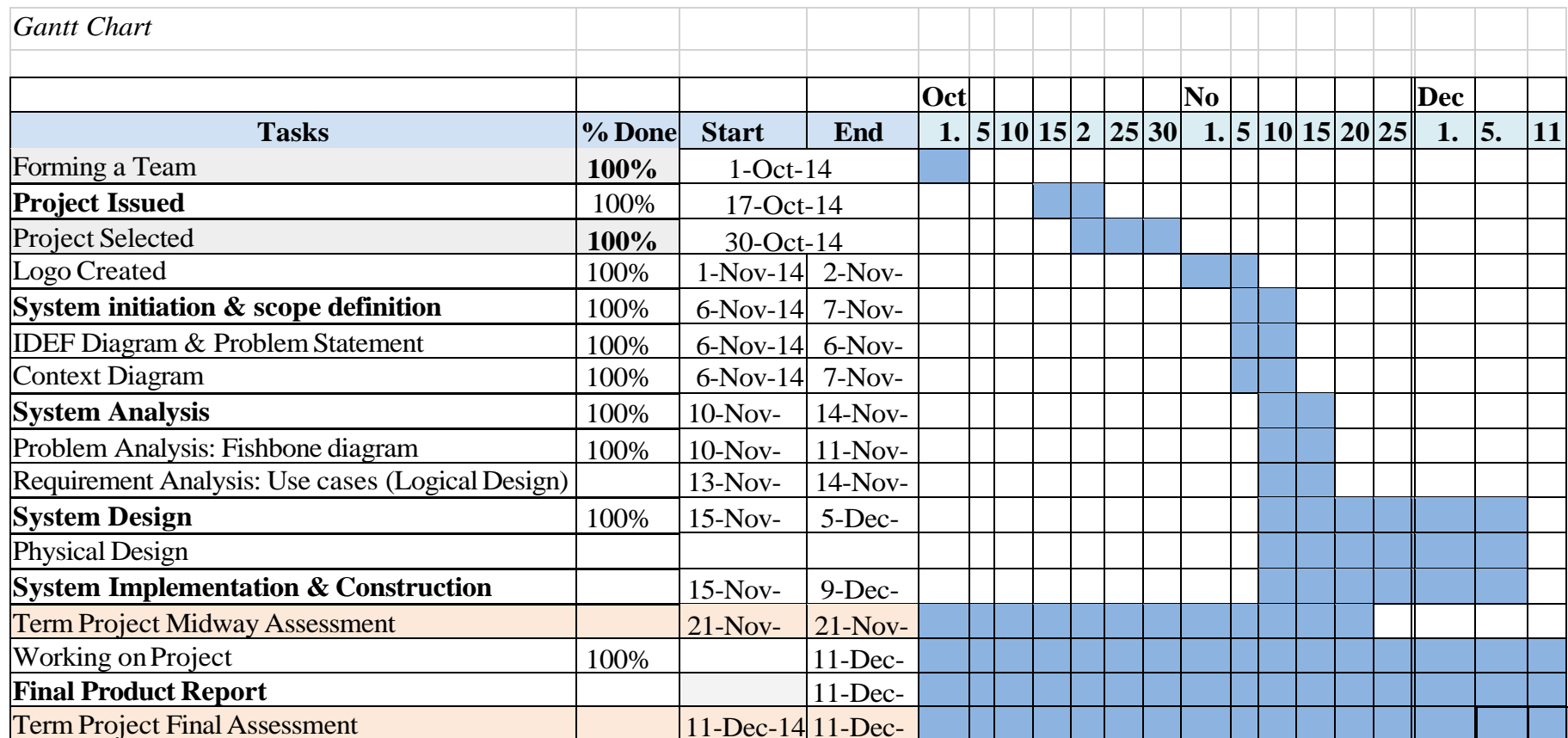


Figure 18: Project Management & Scheduling preview

4. Results

Using VBA and RSP Solver code the problem was optimized. The results were as follows.

Decision Variables					Constraints	
X1	10.00			10.00	\geq	9.16
X2	5.00			15.00	\geq	15
X3	0.00			15.00	\geq	13.3
X4	0.00			21.00	\geq	15.5
X5	6.00			15.00	\geq	14.1
X6	4.00			8.00	\geq	7.5
X7	4.00			4.00	\geq	3.33
	Salary			Objective		2304
X1	112.00					
X2	112.00					
X3	116.00					
X4	120.00					
X5	40.00					
X6	48.00					
X7	48.00					

Optimal number of full-time and part-time employees to work in each shift are

X1	10.00
X2	5.00
X3	0.00
X4	0.00
X5	6.00
X6	4.00
X7	4.00

From running the solver, we we're able to identify and develop the optimal cost of operating the call center which is **\$2304.00**. This means that by allocating the right number of employees (full-time and part-time) for the seven time slots based on the activity of each slot (number of calls received), the call center would operate on a cost of that's provided above. Any changes made to parameters; *Decision Variables* and *Constraints*, would affect the Objective Function.

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6. Appendix

Source Code for Data Analysis form

The screenshot shows the Microsoft Visual Basic for Applications editor for the file 'StaffManagementFinalSubmitted.xlsm'. The 'Project - VBAProject' pane on the left lists the project structure, including 'Microsoft Excel Objects' (Sheets 1-7), 'Forms' (DataAnalysis, frmShiftScheduling, Welcome), 'Modules', and 'References'. The 'Properties - DataAnalysis' pane at the bottom left shows the properties for the 'DataAnalysis UserForm', such as Name, BackColor, BorderColor, and Font. The main editor window displays the following VBA code for the 'UserForm' class:

```
Private Sub btnSolve_Click()
    Worksheets("Data Sheet").Activate

    'Declarations
    Dim i As Integer
    Dim NoShift As Integer
    Dim NumCons As Integer
    Dim prob As New RSP.Problem
    Dim MyVar As New Variable
    Dim constraints() As New RSP.Function, obj As New RSP.Function

    NoShift = 7
    Application.ScreenUpdating = False
    prob.Variables.Clear
    prob.Functions.Clear

    'Defining Ranges
    Range(Range("H2"), Range("H2").Offset(NoShift - 1, 0)).Name = "DecVar"
    Range("O1").Name = "ObjectiveFn"
    Range("I1").Name = "LHSconstraint"
    Range("L1").Name = "RHS"

    'Integer Variables
    MyVar.Init Range("DecVar")
    MyVar.IntegerType.Array = Integer_Type_Integer
    prob.Variables.Add MyVar
    Set MyVar = Nothing

    'Objective Function
    obj.Init Range("ObjectiveFn")
    obj.FunctionType = Function_Type_Objective
    prob.Functions.Add obj
    Set obj = Nothing

    'Constraints
    Range("H1").Activate
    Range("LHSconstraint").Offset(1) = Range("H2").Value
    Range("LHSconstraint").Offset(2) = Range("H2").Value + Range("H3").Value
    Range("LHSconstraint").Offset(3) = Range("H2").Value + Range("H3").Value + Range("H4").Value
    Range("LHSconstraint").Offset(4) = Range("H2").Value + Range("H3").Value + Range("H4").Value + Range("H5").Value + Range("H6").Value
    Range("LHSconstraint").Offset(5) = Range("H3").Value + Range("H4").Value + Range("H5").Value + Range("H6").Value + Range("H7").Value
    Range("LHSconstraint").Offset(6) = Range("H4").Value + Range("H5").Value + Range("H7").Value + Range("H8").Value
    Range("LHSconstraint").Offset(7) = Range("H5").Value + Range("H8").Value

    NumCons = NoShift

    ReDim constraints(NumCons) As New RSP.Function

    NumCons = NoShift
    ReDim constraints(NumCons) As New RSP.Function

    For i = 1 To (NumCons)
        constraints(i).Init Range("LHSconstraint").Offset(i)
        constraints(i).Relation Cons Rel_GE, Range("RHS").Offset(i).Value
        constraints(i).FunctionType = Function_Type_Constraint
        prob.Functions.Add constraints(i)
    Next

    'Solve
    prob.Solver.SolverType = Solver_Type_Minimize
    prob.Solver.Optimize Solve_Type_Solve
End Sub
```

Source Code for Shift Scheduling form

Microsoft Visual Basic for Applications - StaffManagementFinalSubmitted.xlsm - [frmShiftScheduling (Code)]

File Edit View Insert Format Debug Run Tools Add-Ins Window Help

Project - VBAProject

frmSalary

Click

Solver (Solver.xda)

VBAProject (StaffManag)

Sheet1 (Welcome)

Sheet2 (Data Sheet)

Sheet3 (Answer Req)

Sheet4 (Solutions R)

Sheet5 (Structure R)

Sheet6 (Sensitivity /)

Sheet7 (WelcomeSh)

ThisWorkbook

Forms

DataAnalysis

frmShiftScheduling

Welcome

Modules

References

Properties - frmSalary

frmSalary Frame

Alphabetic Categorized

(Name) frmSalary

BackColor 8H00FF8

BorderColor 8H8000012

BorderStyle 0 - fmBorderStyle

Caption Shift Salary

ControlTipText

Cycle 0 - fmCycleAllFo

Enabled True

FontTahoma

ForeColor 8H8000012

Height 372

HelpContextID 0

KeepScrollBarsVisi 3 - fmScrollBars

Left 0

MouseIcon (None)

MousePointer 0 - fmMousePoi

Picture (None)

PictureAlignment 2 - fmPictureAlig

PictureSizeMode 0 - fmPictureSize

PictureTiling False

ScrollBars 0 - fmScrollBars

ScrollHeight 0

ScrollLeft 0

ScrollTop 0

ScrollWidth 0

SpecialEffect 3 - fmSpecialEff

TabIndex 0

TabStop True

Tag

Top 0

Visible True

Width 534

Zoom 100

```
'Enter Number of Expected Calls
ActiveCell.Offset(1, 0).Value = "7 A.M - 9 A.M"
ActiveCell.Offset(1, 1).Value = Me.txtcall79.Value
ActiveCell.Offset(2, 0).Value = "9 A.M - 11 A.M"
ActiveCell.Offset(2, 1).Value = Me.txtcall911.Value
ActiveCell.Offset(3, 0).Value = "11 A.M - 1 A.M"
ActiveCell.Offset(3, 1).Value = Me.txtcall1111.Value
ActiveCell.Offset(4, 0).Value = "1 P.M - 3 P.M"
ActiveCell.Offset(4, 1).Value = Me.txtcall113.Value
ActiveCell.Offset(5, 0).Value = "3 P.M - 5 P.M"
ActiveCell.Offset(5, 1).Value = Me.txtcall135.Value
ActiveCell.Offset(6, 0).Value = "5 P.M - 7 P.M"
ActiveCell.Offset(6, 1).Value = Me.txtcall157.Value
ActiveCell.Offset(7, 0).Value = "7 P.M - 9 P.M"
ActiveCell.Offset(7, 1).Value = Me.txtcall179.Value

'creating table for decision variable
Range("G1").Activate
Range("G1").Value = "Decision Variable"

For i = 1 To NoShift
    Range("G1").Offset(i, 0).Value = "X" & i
Next i
Range("G1:H2").Borders(xlInsideHorizontal).Weight = xlMedium
Range(Range("G2"), Range("G2").Offset(NoShift - 1, 1)).Borders(xlInsideVertical).Weight = xlMedium
Range(Range("G1"), Range("G1").Offset(NoShift, 1)).BorderAround LineStyle:=xlSolid, Weight:=xlMedium
Range("H2").Activate

'creating table for constraints
Range("J1").Activate
Range("J1:L2").Borders(xlInsideHorizontal).Weight = xlMedium
Range(Range("J1"), Range("J1").Offset(NoShift, 1)).Borders(xlInsideVertical).Weight = xlMedium
Range(Range("K1"), Range("K1").Offset(NoShift, 1)).Borders(xlInsideVertical).Weight = xlMedium
Range(Range("J1"), Range("J1").Offset(NoShift, 2)).BorderAround LineStyle:=xlSolid, Weight:=xlMedium

avgcall = Me.txtavgcalls.Value

Range("K1").Activate
For i = 1 To NoShift
    ActiveCell.Offset(i, 0).Value = ">="
Next i

Range("I1").Activate

For i = 1 To NoShift
    ActiveCell.Offset(i, 0).Value = ActiveCell.Offset(i, -10).Value / avgcall
Next i

'Objective Function
Range("N1").Value = "Obejctive function"
Range("N1:O1").BorderAround LineStyle:=xlSolid, Weight:=xlMedium
Range("N1:O1").Borders(xlInsideVertical).Weight = xlMedium

End Sub

Private Sub cmdsolver_Click()
Worksheets("Data Sheet").Activate
frmShiftScheduling.Hide
DataAnalysis.Show
End Sub
```

Source Code for Welcome form

